PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference SHW:LM:FP18344	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. **PCT/AU2003/001156**	International Filing Date *(day/month/year)* 5 September 2003	Priority Date *(day/month/year)* 11 September 2002

International Patent Classification (IPC) or national classification and IPC

Int. Cl. [7] F02M 53/06, 31/125

Applicant

VAPORATE PTY LTD et al

This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

[X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 6 sheet(s).

3. This report contains indications relating to the following items:

- I [X] Basis of the report
- II [ ] Priority
- III [ ] Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV [X] Lack of unity of invention
- V [X] Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI [ ] Certain documents cited
- VII [ ] Certain defects in the international application
- VIII [ ] Certain observations on the international application

Date of submission of the demand	Date of completion of the report
8 April 2004	28 July 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **R. SUBBARAYAN** Telephone No. (02) 6283 2377

I. Basis of the report

1. With regard to the elements of the international application:*

- [ ] the international application as originally filed.
- [X] the description, pages **1-30**, as originally filed,
  pages , filed with the demand,
  pages , received on with the letter of
- [X] the claims, pages **31, 32**, as originally filed,
  pages , as amended (together with any statement) under Article 19,
  pages , filed with the demand,
  pages **33-38,** received on **29 June 2004** with the letter of **28 June 2004**
- [X] the drawings, pages **1/15-15/15,** as originally filed,
  pages , filed with the demand,
  pages , received on with the letter of
- [ ] the sequence listing part of the description:
  pages , as originally filed
  pages , filed with the demand
  pages , received on with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

- [ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- [ ] the language of publication of the international application (under Rule 48.3(b)).
- [ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- [ ] contained in the international application in written form.
- [ ] filed together with the international application in computer readable form.
- [ ] furnished subsequently to this Authority in written form.
- [ ] furnished subsequently to this Authority in computer readable form.
- [ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- [ ] The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. [ ] The amendments have resulted in the cancellation of:
   - [ ] the description, pages
   - [ ] the claims, Nos.
   - [ ] the drawings, sheets/fig.

5. [ ] This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- [ ] restricted the claims.
- [ ] paid additional fees.
- [ ] paid additional fees under protest.
- [ ] neither restricted nor paid additional fees.

2. [X] This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- [ ] complied with.
- [X] not complied with for the following reasons:

1) Claims 1-10 are directed to a fuel delivery system wherein heat is conducted from the engine via a heat conducting gasket to the inlet manifold and then to the end region of a fuel injector. It is considered that the heat conducting gasket comprises a first special technical feature.

2) Claims 11-25 are directed to a fuel delivery system having electrical heating means for heating the end region of the injector. It is considered that the electrical heating means comprises a second special technical feature.

Since these groups of claims do not share any of the special technical features identified, a technical relationship between the inventions does not exist. Accordingly the claims do not relate to one invention or to a single inventive concept, a priori.

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- [X] all parts.
- [ ] the parts relating to claims Nos.

V. **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-25	**YES**
	Claims		**NO**
Inventive step (IS)	Claims	1-25	**YES**
	Claims		**NO**
Industrial applicability (IA)	Claims	1-25	**YES**
	Claims		**NO**

2. Citations and explanations (Rule 70.7)

None of the documents cited in the International Search Report disclose individually or in combination a fuel delivery system or a fuel injector as defined in independent claims 1, 11, 13, 19 & 24. The claimed invention is considered novel, inventive and industrially applicable.

9. The system of claim 7 wherein the electrical heating means comprises a coil wound around the end region, electric leads for supplying current to the coil so that the passage of current through the coil generates heat to the heat the end region.

10. The system of claim 1 wherein the system includes temperature sensing means for monitoring the temperature of the engine in the vicinity of the fuel injector for switching off the electrical heating means when the engine temperature reaches a predetermined temperature whereby sufficient heat is conducted from the engine to the end region to heat the fuel in the end region.

11. A fuel injector for an internal combustion engine having a piston moveable in a cylinder, the injector comprising:

an end region;

a body;

electrical componentry in the body operable to enable fuel to be ejected from the end region of the injector;

electrical heating means on the external surface of the end region for heating the end region of the injector, but not the body, so that when fuel is located in the injector and the electrical heating means operated, the fuel is ejected from the end region of the injector and substantially immediately converts to vapour because of the heating of the end region and therefore the fuel in the end region, and the change in pressure experienced by the fuel as the fuel leaves the end region of the injector; and

wherein the electrical heating means comprises an electrical heating pad in electrical contact with the end region, an insulating member between the pad and the engine, and an insulated electrical conductor in electrical communication with the pad so that current is

supplied to the pad and then flows through the end region to heat the end region.

12. The system of claim 11 wherein the electrical heating means comprises an insulated heating coil wound around the end region, and electrical conductors for supplying current to the coil so that the passage of current through the coil generates heat to heat the end region.

13. A fuel delivery system for an engine which has a combustion chamber, a piston movable in the combustion chamber, an air inlet port and an exhaust port, comprising:

an injector port in the engine having a first open end communicating with the combustion chamber, and a second end remote from the first end, the injector port having an injector port wall;

a fuel injector located in the injector port, the fuel injector having an injector main body which houses electrical components for operating of the injector, an injection tip and an end region adjacent the tip, the end region being for storing fuel to be ejected from the injector;

an electrical heating element surrounding the end region exterior of the fuel injector;

an electric current supply for supplying current to the heating element for heating the end region of the injector to in turn heat the fuel in the end region so that when the fuel leaves the injector, the fuel substantially immediately converts to vapor because of the heating of the fuel and the change in pressure experienced by the fuel when the fuel leaves the injector; and

wherein the current supply device comprises a battery for supplying current and a pulse width modulator for modulating the current supplied by the battery so that the current supplied to the heating element is pulsed

width modulated so that the amount of current supplied to the heating element can be controlled to thereby control the heating of the heating element, and therefore the heating of the fuel within the injector end region.

14. The system of claim 13 wherein the heating element is provided in a cylindrical sleeve which locates over the end region of the injector, and sits between the end region of the injector and the injector port wall of the injector port in the engine.

15. The system of claim 13 wherein the current supply comprises at least one conductor extending from the heating element to a current supply device.

16. The system of claim 13 wherein the current supply includes a relay so that current is supplied when the relay is closed, and a control current supply for closing the relay.

17. The system of claim 16 wherein the control current supply comprises a signal from a fuel pump relay which passes through an engine temperature sensor so that if the engine temperature is below a predetermined temperature, the relay is closed to thereby enable current to be supplied to the heating element.

18. The system of claim 17 wherein the fuel injector includes a temperature sensor for monitoring the temperature of the fuel in the end region and for opening the relay when the temperature reaches a predetermined temperature.

19. An injector for injecting fuel into an engine, comprising:

an injector body having a tip, an end region adjacent the tip for storing fuel, and a main body portion

in which electrical components for operating the injector are housed;

the end region having an outer surface formed from heat conducting material;

a heater sleeve arranged on the end region and surrounding the end region, the sleeve including a heater element for receiving electric current to heat the heater element, and therefore conduct heat through the heat conducting outer surface of the end region into the end region of the injector for heating fuel in the end region of the injector so that when the fuel is ejected from the end region the fuel substantially immediately converts to vapor state because of the heating of the fuel and the change in pressure experienced by the fuel when the fuel leaves the injector; and

wherein the sleeve is formed from a high temperature silicon in which the heating element is embedded by molding, the sleeve forming a heat conducting path for conducting heat from the engine through the sleeve to the end region of the injector.

20. The injector of claim 19 wherein the heating element comprises a coiled wire.

21. The injector of claim 20 wherein the coiled wire includes a sheath which surrounds the coiled wire to maintain turns of the coiled wire separated from one another when the coiled wire is molded in the sleeve.

22. The injector of claim 19 wherein a temperature sensor is disposed adjacent the end region of the injector for monitoring the temperature of the end region of the injector, and therefore the fuel in the end region of the injector.

23. The injector of claim 19 wherein the heater sleeve includes a central opening having a peripheral wall

for receiving the end region of the injector, and the temperature sensor is arranged between the end region of the injector and the peripheral wall.

24. A fuel delivery system for an engine which has a combustion chamber, a piston moveable in the combustion chamber, an air inlet port, an air inlet port and an exhaust port, comprising:

an injector port in the engine having a first open end communicating with the combustion chamber, and a second end remote from the first end, the injector port having an injector port wall;

a fuel injector located in the injector port, the fuel injector having an injector main body which houses electrical components for operating the injector, an injector tip and an end region adjacent the tip, the end region being for storing fuel to be ejected from the injector;

an electrical heating element for heating the fuel in the end region of the injector;

an electrical current supply for supplying current to the heating element for heating the end region of the injector;

a heat conducting path from the engine to the end region of the injector so the end region of the injector can be heated by heat conducted from the engine;

a current shut-off for shutting off supply of current to the electrical heating element; and

whereupon initial startup of the engine, current is supplied to the electrical heating element to heat the fuel in the end region of the engine, and after initial heating of the fuel in the end region, the current shut-off shuts off current to the engine so the end region is continued to be heated by direct conduction of heat from the engine through the direct conduction path.

25. The system of claim 24 wherein the injector port is located in a manifold connected to the air inlet port and the direct conduction path includes a heat conducting gasket between the inlet port and the manifold for conducting heat to the manifold and then to the end region of the injector.

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